IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:	)	
	)	
Fradkin et al.	)	
	)	
Serial No.: 10/535,466	)	Group Art Unit: 2624
	)	
Filed: May 17, 2005	)	Examiner: Sathyanaraya V. Perungavoor
	)	
For: IMAGE PROCESSING SYSTEM FOR AUTOMATIC ADAPTATION OF A 3-D MESH MODEL ONTO A 3-D SURFACE OF AN OBJECT	)	**Board of Patent Appeals and Interferences**
	)	
Confirmation No.: 6154	)	

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APPEAL BRIEF UNDER 37 C.F.R. § 41.37

In support of the Notice of Appeal filed on April 21, 2009 and pursuant to 37 C.F.R. § 41.37, Appellants present this appeal brief in the above-captioned application.

This is an appeal to the Board of Patent Appeals and Interferences from the Examiner's final rejection of claims 1-15 in the Final Office Action dated January 21, 2009. The appealed claims are set forth in the attached Claims Appendix.

1. Real Party in Interest

This application is assigned to Koninklijke Philips Electronics N.V., the real party in interest.

2. Related Appeals and Interferences

There are no other appeals or interferences that would directly affect, be directly affected, or have a bearing on the instant appeal.

3. Status of the Claims

Claims 1-15 have been rejected in the Final Office Action. The final rejection of claims 1-15 is being appealed.

4. Status of Amendments

All amendments submitted by Appellants have been entered.[1]

5. Summary of Claimed Subject Matter

The present invention, as recited in independent claim 1, proposes an image processing system having image data processing means of automatic adaptation of 3-D Mesh Model to image features, for Model-based image segmentation. (See Specification, p. 6, ll. 3-5). The system comprises a means of dynamic adaptation of the Model resolution to image features including means of locally setting higher resolution when reliable image features are found and means of setting lower resolution in the opposite case. (See Specification, p. 6, ll. 5-20). The system further comprises a viewing means for visualizing the images. (See Specification, p. 10, l. 23 to p. 11, l. 2, and Fig. 4).

The present invention, as recited in independent claim 15, is directed at an image processing method. (See Specification, p. 3, ll. 28-29). The first step is acquiring image data of a 3-D image with image features. (See Specification, p. 3, l. 30). The next step is automatically

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[1] Appellants note that an Amendment was submitted on March 23, 2009, in response to the Final Office Action. In the Advisory Action mailed on March 31, 2009, the Examiner indicated that this Amendment would not be entered for purposes of appeal. (See 3/31/09 Advisory Action, item 7). Thus, the claims being appealed are those that were pending at the time of the issuance of the Final Office Action. Please refer to the Claims Appendix.

adapting 3-D Mesh Model to image features. (See Specification, p. 6, ll. 3-5). The next step is for Model-based image segmentation. (See Specification, p. 6, l. 24). The next step dynamically adapts the Model resolution to image features including locally setting higher resolution when reliable image features are found and setting lower resolution in the opposite case. (See Specification, p. 7, ll. 9-21). The final steps comprise of steps of visualizing the images to refine the fitness of the matching between the mesh model and the object of reference. (See Specification, p. 7, ll. 22-30, p. 8, ll. 22-23, and Fig. 3).

6. Grounds of Rejection to be Reviewed on Appeal

I. Whether claims 1, 2, and 15 are obvious under 35 U.S.C. § 103(a) in view of "General Object Reconstruction Based on Simplex Meshes" by Delingette, published in the International Journal of Computer Vision, vol. 32, pp. 111-142, 1999 (hereinafter "Delingette").

II. Whether claims 3-7 are obvious under 35 U.S.C. § 103(a) in view of Delingette in further view of U.S. Patent No. 6,968,299 to Bernardini et al. (hereinafter "Bernardini").

III. Whether claims 8-14 are obvious under 35 U.S.C. § 103(a) in view of Delingette in view of Bernardini and U.S. Patent No. 6,201,889 to Vannah (hereinafter "Vannah").

7. Argument

I. The Rejection of Claims 1, 2, and 15 Under 35 U.S.C. § 103(a) Over Delinguette Should Be Reversed.

A. The Examiner's Rejection

In the Final Office Action, the Examiner rejected claims 1, 2, and 5 under 35 U.S.C. § 103(a) as being unpatentable over Delinguette. (See 1/29/09 Office Action, p. 2-3 and 7/11/08 Office Action, p. 12-14).

Delingette describes a general tridimensional reconstruction algorithm of volumetric images, based on deformable simplex meshes. (See Delingette, Abstract). In this paper, the author describes a refinement algorithm based on the minimization of a geometric criterion based on the distance to the data or the local curvature. (See Delingette, p. 115, col. 1, para. 3). The simplex meshes are unstructured meshes, and can therefore be locally refined or decimated. (See Delingette, p. 118, col. 2, para. 3).

B. The Cited Patent Does Not Disclose Setting Higher Resolution When Reliable Image Features Are Found and Means of Setting Lower Resolution in the Opposite Case, As Recited In Claim 1.

The Examiner cites specific language from Delinguette to allegedly teach the above recitation and specifically cites to Page 118, column 2, paragraph 2 and table 5, stating "Simplex meshes as triangulations are unstructured meshes and therefore cannot be locally refined." (See 7/11/08 Office Action, p. 12-13). In this passage cited by the Examiner, there is no suggestion of setting a higher resolution when reliable image features are found and setting lower resolution in the opposite case. In fact, Delingette increases its resolution in areas of high curvature. (See Delingette, p. 121, figure 9b). Delingette's refinement measure is linked to the maximum distance to the data. (See Delingette, p. 133, col. 2, para. 5). Also, Delingette states that its algorithm is not sensitive to noise. (See Delingette, p. 127, col. 1, para. 2).

Claim 1 recites "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case." The Examiner asserts that Delinguette teaches this recitation of claim 1. (7/11/08 Office Action, p. 12-14). Appellant respectfully disagrees.

The Examiner asserts that points of high curvature inherently have increased information content in the form of more high frequency content and are consequently more reliable indications of shape than points of low curvature. (See 7/11/08 Office Action, p. 5). Furthermore, the Examiner asserts that, under claim 1, any feature can be qualified as a "reliable image feature," and therefore all high curvature regions qualify as reliable image features. (See 1/21/09 Office Action, p. 2). Applicants submit that having points of high curvature does

necessarily mean that there are more reliable image features. For example, a noisy image region, and hence being an unreliable image feature, may have many points of high curvature. This is because a determination of surface curvature involves taking partial second order derivatives of the surface, and the computation of the partial second order derivatives is very sensitive to noise. A high frequency noise in the image may result in a very high curvature value because the noise is found in the high frequency content. Since a noisy image having high curvature values is not a reliable image feature, therefore, an area having points of high curvature value does not necessarily imply that it is a reliable image feature. Thus, for the present example of an unreliable noisy image feature, the teaching of Delingette would require setting a higher resolution. In contrast, claim 1 recites "setting higher resolution when reliable image features are found and *means of setting lower resolution in an opposite case*." That is, setting a lower resolution when reliable image features are not found. Therefore, Delingette fails to disclose the above stated limitation.

Accordingly, Appellants respectfully submit that Delinguette does not teach or suggest "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case" as recited in claim 1. Thus, the rejection of claim 1 should be withdrawn. Since claim 2 depends from claim 1, this claim is also allowable.

Independent claim 15 recites "setting higher resolution when reliable image features are found and setting lower resolution in the opposite case." Thus, for the same reasons described above with respect to claim 1, Appellants respectfully submit that this claim is also allowable.

II. The Rejection of Claims 3-7 Under 35 U.S.C. § 103(a) Over Delinguette in view of Bernardini Should Be Reversed.

A. The Examiner's Rejection

In the Final Office Action, the Examiner rejected claims 3-7 under 35 U.S.C. § 103(a) as being unpatentable over Delinguette in view of Bernardini. (See 1/29/09 Office Action, p. 2-3 and 7/11/08 Office Action, p. 15-18).

Bernardini discloses a method and apparatus for finding a triangle mesh that interpolates a set of points obtained from a scanner. (See Bernardini, col. 3, ll. 47-49). Multiple scans of an object are aligned into a single coordinate frame, their points forming an unorganized point cloud. (See Bernardini, col. 6, ll. 5-7). The disclosed ball-pivoting algorithm then connects these points as a series of triangles by "rolling" a ball of a given radius between the points. (See Bernardini, Abstract). The algorithm continues until all the points in the cloud have been considered. (See Bernardini, Abstract). The algorithm generates an output mesh that is a manifold subset of an alpha-shape of the point cloud. (See Bernardini, col. 5, ll. 33-35). The alpha shapes are an effective tool for computing the "shape" of the point cloud. (See Bernardini, col. 7, lines 18-19). The final output is a representation of the geometry of the scanned object in a computer model. (See Bernardini, col. 1, ll. 30-31).

B. The Cited Patents Do Not Disclose Setting Higher Resolution When Reliable Image Features Are Found and Means of Setting Lower Resolution in the Opposite Case, As Recited In Claim 1.

Claim 1 recites "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case." The Examiner asserts that Delinguette, in view of Bernardini, teaches claims 3-7, which depend on claim 1. (7/11/08 Office Action, p. 15-18). Appellant respectfully disagrees.

Bernardini considers sources of error in its measurement system. (See Bernardini, col. 1, lines 41-53, and col. 7, l. 24 through col. 9, l. 11). There are two sources of error: error in registration, and error along the sensor line of sight. (See Bernardini, col. 1, ll. 49-51). Typical problems are missing points, non-uniform density, imperfectly aligned overlapping range scans, scanner line of sight error, and outliers. (See Bernardini, col. 8, ll. 12-20). These are the problems that Bernardini considers "noise." Bernardini has ways of dealing with each problem. First, Bernardini discusses the holes created by "missing points." The points can be missing for several different reasons, including non-uniform density of the scanned point cloud, whether parts of the surface were not scanned, or when the points are missing because of some line of sight error. (See Bernardini, col. 8, ll. 5-11 and 26-57). Due to these "noise" errors, certain parts

of Bernardini's surface will be unreliable. In this situation, Bernardini teaches a method of filling these holes in, *increasing the resolution* in these areas, rather than decreasing the resolution. (See Bernardini, col. 8, ll. 44-57). For instance, it describes a process of filling the holes in by applying the ball-rolling algorithm multiple times, increasing the ball radius each time. (See Bernardini, col. 8, lines 44-48). Second, Bernardini discusses the errors caused by improperly aligned overlapping scans. (See Bernardini, col. 8, l. 58 through col. 9, l. 6). The noisy sample forms two layers, distant enough to allow the ball to walk on both layers. (See Bernardini, col. 8, lines 60-62). When Bernardini encounters this phenomenon, it *increases the resolution* of that noisy area by allowing the formation of undesired small connected components lying close to the main surface. (See Bernardini, col. 8, ll. 62-64). Although the seed triangle selection process tries to avoid creating a large number of these small components, post-processing is required to remove them and smooth the surface. (See Bernardini, col. 8, l. 64 through col. 9, l. 6). Finally, Bernardini discusses the problem of outliers. (See Bernardini, col. 8, ll. 15-20). Bernardini suggests that outliers should be removed by the scanning device in pre-processing, thus simply *ignoring* this type of noise.

Thus, for these examples of unreliably noisy image features, the teachings of Bernardini would require either using a higher resolution, or simply ignoring the problem. In contrast, as described above, claim 1 recites "setting higher resolution when reliable image features are found and *means of setting lower resolution in an opposite case*." That is, setting a lower resolution when reliable image features are not found.

Accordingly, Appellants respectfully submit that Delinguette, in view of Bernardini, does not teach or suggest "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case" as recited in claim 1. Since claims 3-7 depend from claim 1, these claims are allowable, and the rejection should be withdrawn.

III. The Rejection of Claims 8-14 Under 35 U.S.C. § 103(a) Over Delinguette in view of Bernardini and Vannah Should Be Reversed.

A. The Examiner's Rejection

In the Final Office Action, the Examiner rejected claims 3-7 under 35 U.S.C. § 103(a) as being unpatentable over Delinguette in view of Bernardini and in further view of Vannah. (See 1/29/09 Office Action, p. 2-3 and 7/11/08 Office Action, p. 18-23).

Vannah discloses a method and apparatus for determining and recording the 3-D topography of various scalar properties of objects, such as organs in the body. (See Vannah, col. 3, ll. 8-10). Vannah assigns each sample data point to a compartment within the computer model (See Vannah, col. 3, ll. 15-24 and col. 4, ll. 53-61). A quality value for each sample point is determined, based on the quality of the signal, and these quality values are recorded in the compartments. (See Vannah, col. 3, ll. 24-28). The algorithm then recalculates the data points when the quality value indicates that it is unacceptable, and assigns a new quality value. (See Vannah, col. 3, ll. 28-35). The steps are repeated until all the compartments have an acceptable quality value. (See Vannah, col. 3, ll. 35-40).

B. The Cited Patents Do Not Disclose Setting Higher Resolution When Reliable Image Features Are Found and Means of Setting Lower Resolution in the Opposite Case, As Recited In Claim 1.

Claim 1 recites "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case." The Examiner asserts that Delinguette, in view of Bernardini, and in further view of Vannah, teaches claims 8-14, which depend on claim 1. (7/11/08 Office Action, p. 18-23). Appellant respectfully disagrees.

Vannah considers the quality of the data it measures. "Quality is defined in terms of accuracy and quantity of the sampled data. (See Vannah, col. 4, ll. 45-47). Quality is low when there are widespread discrepancies between sampled points in a given region, or when there are too few sampled points in a given region. (See Vannah, col. 4, ll. 47-51). When Vannah encounters the problem of low quality, it directs the operator to obtain more samples in those areas, thereby *increasing the resolution.* (See Vannah, col. 4, l. 66 to col. 5, l. 1).

Specifically, Vannah notes that noisy, poor quality areas are heavily corrected, and high quality areas are minimally corrected. (See Vannah, col. 5, ll. 16-19).

Thus, for these examples of noisy, poor quality image features, the teachings of Vannah would require either using a higher resolution. In contrast, as described above, claim 1 recites "setting higher resolution when reliable image features are found and *means of setting lower resolution in an opposite case*." That is, setting a lower resolution when reliable image features are not found.

Accordingly, Appellants respectfully submit that Delinguette, in view of Bernardini, and in further view of Vannah, does not teach or suggest "setting higher resolution when reliable image features are found and means of setting lower resolution in an opposite case" as recited in claim 1. Since claims 8-14 depend from claim 1, these claims are allowable, and the rejection should be withdrawn.

8. Conclusion

For the reasons set forth above, Appellants respectfully request that the Board reverse the rejection of the claims by the Examiner under 35 U.S.C. § 103(a), and indicate that claims 1-15 are allowable.

Respectfully submitted,

Date: June 18, 2009

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CLAIMS APPENDIX

1. (Previously Presented) An image processing system having image data processing means of automatic adaptation of 3-D Mesh Model to image features, for Model-based image segmentation, comprising means of dynamic adaptation of the Model resolution to image features including means of locally setting higher resolution when reliable image features are found and means of setting lower resolution in the opposite case; and comprising viewing means for visualizing the images.

2. (Previously Presented) The system of claim 1, having data processing means to define a feature confidence parameter for each image feature, and to locally adapt model resolution according to it.

3. (Previously Presented) The system of claim 2, having data processing means to define a feature confidence parameter as a parameter that depends on the feature distance and on the estimation of quality of this feature including estimation of noise, and having data processing means to penalize the large distances and the noisy, although close features.

4. (Previously Presented) The system of claim 3, having data processing means for decreasing the resolution of the Model in absence of confidence and gradually increasing the resolution of the Model with the rise of feature confidence.

5. (Previously Presented) The system of claim 4, having data processing means for causing low local resolution to constrain local surface curvature, for preventing the model surface from self-intersections.

6. (Previously Presented) The system of one of claims 1 to 5, having means to make feature confidence available for model adaptation, comprising means to display the Model regions with different colors representing the confidence at the location of said regions for the user to supervise the deformation process of the Model and to locally assess its final quality.

7. (Previously Presented) Image processing system of claim 6, for the segmentation of a three dimensional object in a three dimensional image including data processing means for mapping a three dimensional mesh model onto said three dimensional object comprising means for: Acquiring a three-dimensional image of an object of interest to be segmented, generating a Mesh Model, formed of polygonal cells and deforming the Mesh Model in order to map said Mesh Model onto said object of interest.

8. (Previously Presented) The image processing system of claim 7, further comprising means for: Constructing a Color Coding Table wherein predetermined colors are associated to given confidence parameter values; Associating the confidence parameter values of a given cell of the Mesh Model to a color given by the color coding Table corresponding to said confidence parameter values.

9. (Previously Presented) The image processing system of claim 8, further comprising data processing means for: Performing a color coding operation by attributing to said given cell, the color determined from the Color Coding Table, corresponding to the confidence parameter values; and display means for: Displaying the image of the Mesh Model having cells colored according to the color-coding operation.

10. (Previously Presented) The image processing system of claim 9, wherein the color-coding operation is performed for all the cells or for a predetermined number of cells.

11. (Previously Presented) The image processing system of claim 10, further comprising means for: Taking a decision to stop the process of mapping the Mesh Model onto the object of reference in function of a predetermined confidence level.

12. (Previously Presented) A medical imaging system comprising a suitably programmed computer or a special purpose processor having circuit means, which are arranged to form an image processing system as claimed in claim 11 to process medical image data; and display means to display the images.

13. (Previously Presented) A medical examination imaging apparatus having: Means to acquire a three-dimensional image of an organ of a body, and a medical imaging system according to claim 12

14. (Previously Presented) A computer readable medium storing a program to control a system, said program comprising a set of instructions to be used in the system as claimed in claim 11.

15. (Previously Presented) An image processing method, comprising steps of: acquiring image data of a 3-D image with image features, and automatically adapting 3-D Mesh Model to image features, for Model-based image segmentation, whereby: dynamically adapting the Model resolution to image features including locally setting higher resolution when reliable image features are found and setting lower resolution in the opposite case; and comprising steps of visualizing the images.

EVIDENCE APPENDIX

No evidence has been entered or relied upon in the present appeal.

RELATED PROCEEDING APPENDIX

No decisions have been rendered regarding the present appeal or any proceedings related thereto.